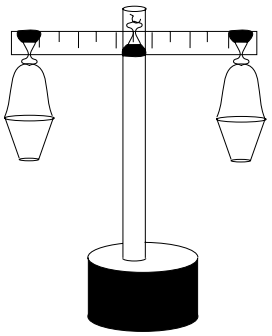
ICE Devices



The "One-Dollar" Balance

Your students can make their own balances, with supplies that you can get in any craft store. These balances are sensitive enough to measure a mass difference of 0.25 g.

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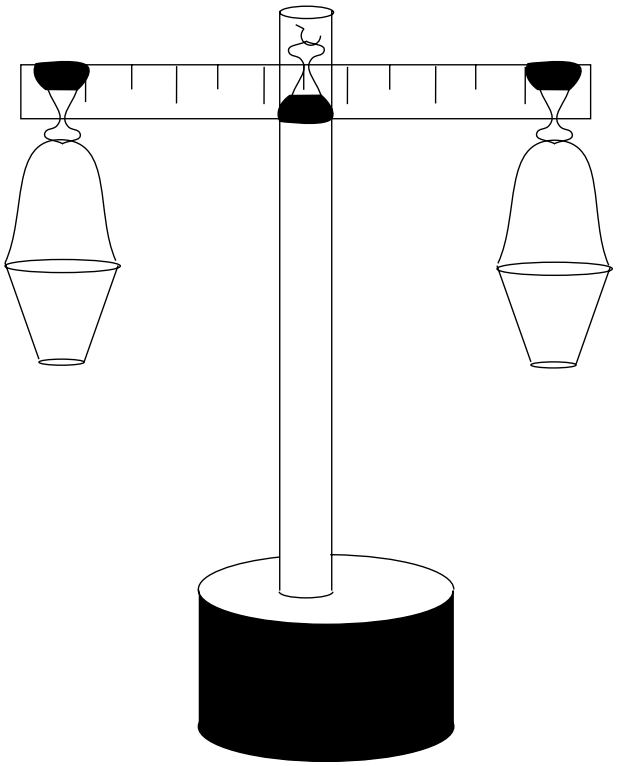
The "One-Dollar" Balance

Design by Theresa Thewes and Diane Sienicki, with modifications by R. A. Shaner

Your students can make their own balances, with supplies that you can get in any craft store. These balances are sensitive enough to measure a mass difference of 0.25 g.

Materials

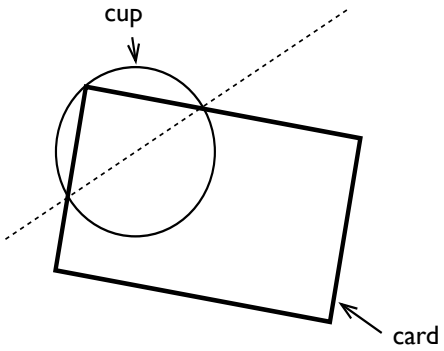
- __ *1 flat-bottomed container with a minimum diameter of 3.5" and minimum height of 1", e.g., plastic container from supermarket deli or tin can from tuna fish*
- __ *2 10"-lengths 0.04" diameter trimmer line or nylon thread*
- __ *plaster of Paris*
- __ *2 9-oz colorless plastic cups*
- __ *sewing needle or safety pin*
- __ *lighter or matches*
- __ *1 12"-long, 3/4"-dia. dowel*
- __ *1 12" ruler (1" wide)*
- __ *3 binder clips (3/4" wide)*
- __ *1 threaded cup hook*
- __ *1/16" drill bit and drill, or hammer and nail*
- __ *permanent marker, any color*
- __ *index card*
- __ *measuring cup*
- __ *pliers*
- __ *scissors*
- __ *plastic utensil or old kitchen knife*



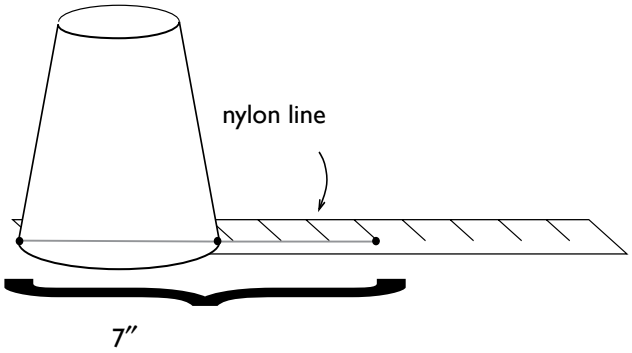
Procedure

1. Screw the threaded hook into the dowel about 5/8" away from the end of the dowel. (If the wood is too hard, you may have to pre-drill a small hole for the hook. You might be able to make a small hole by hammering in a nail about 1/4" down and then removing it, but this might risk splitting the dowel.) You will need to use pliers to make the final turns. The tip of the hook should be pointing toward the top, the nearest end of the dowel.

2. To make the base of the balance mix about 1/3 cup water and 2/3 cup plaster of Paris in the tin can or deli container. Insert the dowel upright into the plaster, with the hook end at the top. Allow to set until firm (about 20 minutes).
3. Attach the three binder clips to the 12″ ruler—one at each end and one at the middle. The clip in the middle should face in the direction opposite those at the ends. Position the metal loops of the binder clips in the closed position.
4. a. Place an index card across the opening of a cup so that one corner is touching the rim (see right). The card edges cross the circumference of the cup at two points. Mark these points on the cup rim. Repeat with the second cup.



   b. Directly beneath the lips of the cups, at the marks, make holes with a hot needle tip. Test to see whether the holes are big enough for the nylon thread to pass through. If they are not, reheat the needle and increase the diameter of the holes.
5. With a lighter or a lighted match, melt one end of each of the lengths of trimmer line so that beads of plastic form that are larger than the holes. Poke one of the lengths of line through **one** of the holes on a cup. [If you are using nylon thread, you may need to tie knots in the ends and then melt the knots.] Repeat with the other cup.
6. Pull the line of one cup through both metal loops of a closed binder clip attached at the end of the ruler, and then feed it through the second hole in the cup. Repeat with other cup and other binder clip.
7. In the completed balance, the cups should be, as closely as possible, to the same height, therefore, care is required in this next step. Lay the ruler flat on your work surface so that you can read the scale. Position the left cup upside down so that the tied off line is at the end of the ruler. Stretch out the line passing through both cup holes so that you can measure its length. Cut the line to 7″; then melt the end to form a bead of plastic. Repeat for the second cup at the right end of the ruler. (Remember that you are now measuring by subtraction, that is, 12″ − 7″ = 5″; cut the line at the 5″ position on the ruler.) [If you are using nylon thread, you will need to tie a knot at 7″ away from the first knot. It may be easier to position the knot by first tying a loose knot and then sliding and tightening it into position. Repeat for the second cup at the right end of the ruler. (Remember that you are measuring by subtraction, that is, 12″ − 7″ = 5″; tie the knot at the 5″ position on the ruler.) Melt both knots so that they form small beads of plastic.]



8. When the plaster base is set, hang the ruler/cup assembly on the hook by the metal loops of the middle binder clip.

Fine Adjustments

If the ruler on your balance does not hang horizontally, slide the two end binder clips along it a fraction of an inch at a time until it does. Adjusting the position of the center binder clip can also help.

Suggestions for standard masses

paper clips

*pennies (either all post-1982 or pre-1982; avoid using 1982 pennies)**

beads

marbles

BBs

Taring and using the balance

1. Place the container that you will use to hold your sample into one of the 9-oz cups. This will be called the sample cup.
2. Tare the balance (bring both sides to the same height) either by changing the positions of the binder clips or by adding standard masses to the other 9-oz cup (the standardizing cup). If you use standard masses, record the number of masses needed to counterbalance the weight of the empty sample container.

3a. ***You want to find out how much a sample weighs:*** Pour the sample into the sample container. Add standard masses to the standardizing cup until the cups are at the same height. Record the number of standard masses needed.

3b. ***You want to weigh out a given amount of sample:*** Add the number of standard masses equal to the amount of sample needed to the empty 9-oz cup. Carefully add just enough sample to counterbalance the standardizing cup.

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* The balance is sensitive enough to measure the difference in weight of a penny made before 1982 and one made after 1982. In 1982 the U. S. Mint switched from manufacturing pennies containing 95% copper and 5% zinc to 2.4% copper and 97.6% zinc, making them lighter and less expensive to produce.